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THE EFFECT OF GIBBERELLIN ON PLANT GROWTH AND DEVELOPMENT

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THE EFFECT OF GIBBERELLIN ON PLANT GROWTH AND DEVELOPMENT

/Following is the translation of selected articles in Fiziologiya Rasteniy (Plant Physiology), Vol. 7, No. 3, 1960./

BRIEF REPORTS*

* These brief reports are devoted to results of tests of gibberellin on various agricultural plants. The tests were organized in 1959 on the initiative of the Growth and Development Laboratory of the Institute of Plant Physiology im. K. A. Timiryazev, Academy of Sciences USSR. In addition, the editors considered it worthwhile to include the report by V. I. Razumov concerning the use of gibberellin for accelerating the flowering of short-day plants.

THE EFFECT OF GIBBERELLIN ON THE GROWTH AND YIELD OF HEMP AND TOBACCO

By M. Kh. Chaylakhyan, V. G. Kochankov, and V. I. Zamota

Institute of Plant Physiology im. K. A. Timiryazev
of the Academy of Sciences USSR, Moscow

(Pages 340-343)

The most striking feature in the effect of gibberellin on plants is its ability to promote growth in the above-ground organs. Thus, it has been established that gibberellin is effective in promoting the formation and growth of plant stems, stem shoots, and leaves, and in intensifying the growth of parthenocarpic fruits [1-6].

In this connection it seemed of great interest to study the effect of gibberellin on crop plants, in particular hemp, whose yield depends upon the length of the stem, and tobacco, whose yield depends on the number and weight of the leaves. Similar tests were conducted by us in the summer of 1959 in the plant house at the Exhibition of Achievements of the National Economy USSR: Chuysk Southern hemp (Cannabis sativa) and Mamont tobacco (Nicotina tabacum) were taken as test media. The tests were conducted in soil placed in 5 kg Mitcherlich culture vessels with the addition of a complete mineral fertilizer prior to seeding.

The seeds of hemp were sown in the vessels on 6 May, and sprouts appeared on 11 May; the seeds of tobacco were sown in flats on 24 March, and sprouts appeared on 31 March; the pricking-out was done on 25 April, and the transplanting into culture vessels (during the two-leaf phase) on 1 June. Originally, there were eight hemp plants in each vessel, and by the end of the test this number was reduced to four or even to two: in the case of tobacco, there was one plant in each vessel through-

out the entire test. The tests began on 19 June and were completed on 3 October.

One-half the hemp and tobacco plants (three vessels of each) were treated with gibberellin, while the other half were grown as controls. The experimental hemp and tobacco plants were sprayed with weak gibberellin solutions on five dates: 19 June, 26 June, 3 July, 10 July, and 8 August; the tobacco plants were given an additional spraying on 7 September. The concentration of the solution used for the first spraying was 0.001 percent, for the second spraying 0.002 percent, and for the subsequent sprayings 0.01 percent. A wetting agent (of either the OP-7 or OP-10 type) in a concentration of 0.05 percent was added to the solution during the spraying. The control plants were sprayed on the same dates with water plus the wetting agent only. When the spraying was started, on 19 June, the hemp plants had grown to heights of 20 cm, with four to five leaves on each plant.

The gibberellin treatment affected the plants quite strongly: there was a noticeable increase in the growth of the plant stems, and eventually, the growth of the experimental plants considerably surpassed that of the control plants (Table 1).

Table 1

The effect of gibberellin on the growth of hemp and tobacco (in cm)

Plants	Test variant	7.6	7.13	7.22	7.29	8.3	8.10	8.19	9.3
Cannabis sativa	Control	111	130	140	160	165	170	185	195
	Gibberellin	182	232	300	350	365	405	445	485
Nicotina tabacum	Control	25	30	45	55	62	70	80	90
	Gibberellin	35	67	110	120	135	160	175	215

The greater growth of the treated plants was accounted for partly by the increase in the length of the internodes and partly by the increase in the number of leaves. During the first growth period the leaves of the experimental plants were considerably larger, but the leaves which apreared later on the hemp plants differed little from those on the respective control plants,

and the later leaves on the tobacco plants were longer but not wider than those of the control plants. The experimental tobacco plants differed from the control plants in that the leaves were of a much lighter shade; on the hemp plants the brightening of the leaves was less marked.

In view of the increased stretching of the stems and in order to ensure normal growth, the plants were systematically provided with additional nutrients.

The increased growth of the experimental hemp plants resulted in their flowering later than the control plants: for the control plants flowering began on 25 August and for the experimental plants it began on 2 September. By the end of the test the experimental hemp plants still had not produced ripe seeds and were in the seed-ripening phase (button phase), whereas the control plants were somewhat riper. Both the experimental and control tobacco plants produced neither flower buds nor flowers and still were in the phase of vegetative growth. At the end of the test, on 3 October, after the plants were measured and photographed, they were removed from the soil and the weight of their above ground mass was recorded. The data obtained are given in Table 2 and in Figs. 1 and 2.

Table 2

The effect of gibberellin on the growth, development, and yield of hemp and tobacco

Plant	Test variants	Development phase of plants	Height of plants, cm	Number of leaves on one plant	Raw weight of one plant, gr	
					male hemp plant	pistillate hemp
Cannabis sativa	Control	Phase of formed seeds	205	-	74	138
	Gibberellin	Phase of partially formed seeds	510	-	185	289
Nicotina tabacum	Control	Vegetative growth	100	22	340	
	Gibberellin	Vegetative growth	250	43	740	

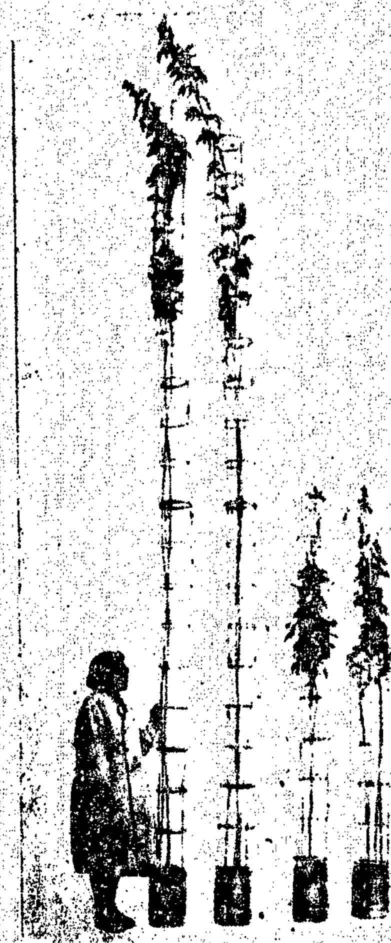

Figure 1. The effect of gibberellin on the growth and development of the southern Chuysk hemp (canabis sativa). Left: two vessels with plants sprayed five times with gibberellin in a concentration of 0.001 to 0.01 percent. Right: the control plants. (Photo taken on 9/28/59)

Figure 2. The effect of gibberellin on the growth and development of Mamont tobacco (Nicotina tabacum). Left: two plants sprayed six times with gibberellin in a concentration of 0.001 to 0.01 pe cent. Right: the control plants. (Photo taken on 9/27/59)

The data given in Table 2 and Figs. 1 and 2 clearly show that under the influence of gibberellin the height of the plants increased two and one half times, the raw weight increased one and a half to two times, and the number of leaves on the tobacco plant doubled.

The impetuous growth of hemp plants that takes place under the influence of gibberellin is undoubtedly of interest for the practice of plant growing. However, at this point two questions arise: (1) to what extent hemp plants over 5 m high are stable to creeping: and (2) what are the yield and technological qualities of the fiber obtained from plants treated with gibberellin.

The answer to the first question can be produced only by tests conducted under varying field conditions

Table 3

The effect of gibberellin on the morphological and technical properties of Cannabis sativa

Indices	Control			Gibberellin		
	Pilstillate hemp	Male hemp plant	Specimen as a whole	Pistillate hemp	Male hemp plant	Specimen as a whole
Number of stems (pieces)	6	4	10	2	3	5
Mean technical length (cm)	178	182	180	371	447	416
Mean diameter of stem at the point half-way of the height (cm)	6.7	6.4	6.6	11.0	8.3	9.4
Diameter of butts (cm)	8.7	8.4	8.6	14.5	12.4	13.2
Overgrowth in leaves and inflorescences (in percent of total wight of plants)	34.3	15.1	26.6	5.5	4.8	5.0
Yield of fiber (in percent of weight of stems)	8.0	10.1	8.8	10.8	12.0	11.5
Duration of watering (hours)	144	96	-	70	70	-
Mean length of elementary fiber (mm)	-	-	9.4	-	-	14.8
Weight staple (percent): up to 15 mm	-	-	65.6	-	-	54.4
15 to 50 mm	-	-	34.4	-	-	45.6
Numerical staple (percent): up to 15 mm	-	-	77.9	-	-	50.8
above 15 mm	-	-	22.1	-	-	40.2

of sowing density, water regime and mineral nutrition. The answer to the second question is given to a certain extent by laboratory data on stems of hemp obtained from investigations conducted at the Central Scientific Research Institute of the Flax and Bast-Fiber Industry (TsNIILV).

Table 3 shows that the treatment of plants with gibberellin results in a substantial increase in the length of the stem (i.e., the length of the plant from the butt to the beginning of branching at the stem's apex): the treatment reduces the necessary soaking time and produces uniform retting of the stem straw; also, it raises the content of fiber in the stems and increases the staple of the elementary fiber.

These preliminary data indicate that the application of gibberellin in the cultivation of hemp may be very promising, and that further testing of hemp under both field and controlled conditions are necessary.

The intensive growth of tobacco stems and the increase in the number of leaves may be of interest to tobacco-growers, provided the quality of leaves can be retained at the same level and the changes in their chemical composition will not have a negative effect on the quality of the yield. We have no data on the chemical composition of the leaves. It would be highly advisable to test gibberellin for its effect on various types of tobacco under controlled and field conditions, and to be sure to match these tests with the chemical analysis of the raw material.

On the whole, the tests indicate the prospects for further testing of the effect of gibberellin on technical cultures such as hemp and tobacco with a view toward increasing their yield and solving the problem of the possible use of gibberellin in the practice of plant growing.

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THE EFFECT OF GIBBERELLIN ON THE GROWTH OF YOUNG TEA SHOOTS

By M. A. Ali-Zade and R. I. Kotomina

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(Pages 343-344)

Gibberellin is notable for its high physiological activity. While promoting the processes of growth, it has a regulating effect on the development of plants [1, 2, 3] and on the yield of the vegetative bulk of various crops [4, 5].

Of substantial interest is the study of the effect of gibberellin on the activation of growth processes in the tea shrub, since the yield of this culture is defined by the yield of the green leaf, which is a direct product of the growth processes. With that end in view we conducted special investigations under field conditions. At the end of September 1959, at the leaf-collecting station of the Lenkoran branch of the Azerbaydzhan Scientific Research Institute of Horticulture, Viticulture, and Subtropical Cultures, we selected a trimmed trellis where the tea shrubs had a nearly uniform appearance. After we had collected the coarse leaves from the shrubs, this trellis was divided into eight parts, each two meters long. Four of these were assigned as control plots and the other four as experimental plots. The experimental and control plots were loc ted in an alternating manner, and thus quadruplication was obtained. The tea shrubs on the experimental lots were sprayed with a solution of gibberellin at a concentration of 200 mg per liter on the following dates: 25, 28, and 29 September and 2 and 5 October, 1959. The solution used on the four experimental plots (totaling eight meters) at each spraying amounted to 300 ml.

On 7 to 8 October we observed the transition of the axillary buds from the period of latent growth to that of visible growth; at this time the spraying was discontinued. Subsequent observations showed the favorable effect of gibberellin on the growth of the young tea shoots. Despite the fall in temperature (the mean temperature of October 1959 was 6° below normal), the axillary branches of the tea shrubs treated with gibberellin vegetated normally, while on the control shrubs the growth was very weak.

Table 1

Growth indices of young tea shrub shoots (on the average, for one shoot)

Test variants	21 October		11 November	
	Length, mm	Number of leaves	Length, mm	Number of leaves
Control	-	-	11.8	0.2*
Gibberellin	29.8	2.2	74.9	3.0

* On the control shrubs there were found individual shoots with one underdeveloped leaf.

The data given in Table 1 show that the young shoots of the tea shrubs treated with the giberellin solution were growing during October and the beginning of November, while on the control shrubs there were only individual shoots which had passed into the period of visible growth. Of importance is the fact that gibberellin cancels the growth-inhibiting effect of the autumnal drop in temperature. During a period of 20 days (from 22 October to 11 November) the average height of the shoot was 45.1 mm, and for the same period the leaf that had appeared on the shoot averaged 0.8 [mm].

It should be noted that gibberellin had a stimulating effect not only on the upper axillary buds: it also initiated growth in the lower buds, as is well demonstrated by the figure.

In order to characterize the rate of appearance of young shoots on the tea shrubs, we counted on 11 November, 1959 the number of the single-, two-, and three-leaf shoots in squares superimposed upon the trellis, the area of the squares being 1,000 cm^2. The average data from four counts are as follows.

Figure 1. The shoot on the left is from an untreated tea shrub, and that on the right is from a tea shrub treated with gibberellin.

The area of the tea shrubs treated with gibberellin produced 12.7 three-leaf, 16.3 two-leaf, and 14.7 single-leaf shoots (a total of 43.7 shoots), which indicated the normal growth of the plant; on the control tea shrubs no tea shoots were found.

It should be noted that in the division of the trellis into plots, the boundary sometimes crossed through the center of a shrub; one half of the shrub fell to the experimental plot and the other half into the control plot. In these cases we were able to observe the growth of young shoots on the part of the shrub treated with gibberellin, in contrast to the growth of the untreated (control) part of the shrub, which was the same as for the other control shrubs.

On 11 November we collected the green leaves and obtained the following yield:

Test variants	Per plot measuring 2.8 m^2	In kg/hectare
Control	0.66	2.35
Gibberellin	42.8	152.80

By the middle of November we obtained from the tea shrubs treated with gibberellin a yield of green leaves worthy of consideration.

We express our thanks to Prof. M. Kh. Chaylakhyan for sending us the gibberellic acid preparation and for advisory assistance.

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THE EFFECT OF GIBBERELLIC ACID ON SEVERAL VARIETIES OF GRAPES

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(Pages 345-348)

Gibberellin, a substance possessing high physiological activity, has been given much consideration in scientific literature. In the Soviet scientific literature there have appeared numerous articles giving brief accounts of results of investigations of the specific features of the effect of gibberellin on the growth and development of various plants [1-4].

The grape plant undoubtedly ranks high among the plants that are of interest from the viewpoint of responsiveness to the effect of gibberellin.

It has been established by the work of foreign authors [5, 6] that the treatment of inflorescences of varieties of seedless grapes with gibberellin solutions brings about quite a considerable increase, sometimes fivefold, in the size of the berries and, consequently, a high increase in yield. According to Weaver [5], this treatment can effectively replace one of the laborious tasks in viticulture -- the ringing of shoots. Under the influence of gibberellic acid the grape bunches become more friable, which reduces their susceptibility to disease [4].

With regard to treating varieties of grape plants with seeds with gibberellin solutions, we find contradictory indications in the literature. Weaver [5] mentions that grape varieties containing seeds in their berries are not responsive to gibberellin treatments. According to the author, this may be explained by the fact that the

seeds form their own gibberellin-like substances which ensure the normal development of the berries. The berries of these varieties show no increase in size after the treatment with gibberellic acid. However, it has been stated [4] that approximately the same result was obtained on varieties of grape with seeds as on those without them.

These test results on the application of gibberellic acid solutions in viticulture prompted us to test the effect of gibberellin on grapes under conditions prevailing in Crimea. Considering the limited amount of information available on its effect on the grape plant, we decided to conduct preliminary observations on varieties with different biological structures. We treated with gibberellin solutions such varieties of seedless grapes as Kishmishi (various) and Askeri, as well as varieties containing normal seeds. The latter group included two types: (1) monoecious, not requiring pollination with pollen of other varieties -- Royal Vinyard and Alburla; (2) varieties with functionally female-type flowers having sterile pollen and therefore requiring pollination with the pollen of other varieties for the normal development of berries -- Nimrag and Pukhlyakovskiy.

The seedless, so-called parthenocarpic berries, which are produced on the varieties of grapes not requiring pollination, are always very small, much smaller than the normal berries of these varieties with normal seeds that develop after pollination. In testing these varieties, we planned to establish the role of the seeds in the response of the grapes to treatments with gibberellin solutions and also the effect of gibberellic acid on the setting and development of parthenocarpic berries.

The gibberellic acid used in most of the tests was produced in the Biological Department of the Czechoslovakian Academy of Sciences.* Also, in testing the Kishmish yellow Alburla varieties, and in some tests on the Nimrag variety, we used the gibberllic acid of the Plant Protection firm (Great Britain), which we obtained from K. Kh. Chaylakhyan, corresponding member of the Academy of Sciences of the Armenian SSR, to whom we are grateful.

* Dr. V. Shevchik was kind enough to send us the gibberellic acid from Prague. We take this opportunity to express our profound gratitude to Dr. Shevchik for his consideration.

The tests were conducted at the Experimental-Production Base of the All-Union Scientific Research Institute of Viticulture and Wine-Making (VNIIVIV) at Magarach, near Yalta. It should be noted that the metereological conditions of that year were not particularly favorable for the grape culture: the amount of atmospheric precipitation during the second half of the summer, which was below normal, and a very cold autumn delayed the ripening of grapes.

The plants were treated with gibberellin solution three times: the first time, before flowering, by briefly submerging the inflorescences with the flower buds in acid solution, the second time by spraying the bunches when the berries were beginning to grow, and the third time by spraying the ripened berries. In the test on the Royal Vineyard variety, the first treatment was given by spraying the shrubs.

The ripe grapes were harvested with due regard for the weight of the berries in each bunch and the number of berries in each bunch. The average weight of a berry was then derived for each bunch, and measurements were made of the length and width of the berries. The average indices were calculated from the test variants. The sugar content of the berry juice of each variant was determined by the refractometric method (the percentage of dry substance in the juice). The number of bunches in the variants varied from four to ten. In addition, the representative bunches in the test variants were photographed.

As a general conclusion, it should be noted first of all that the effect of gibberellic acid on bunches and berries of different varieties of grapes differs widely.

From the seedless grapes the following four varieties were taken for testing: Kishmish (Round, Oval, and Yellow) and Askeri. A summary of the results obtained on the four varieties is given in Table 1.

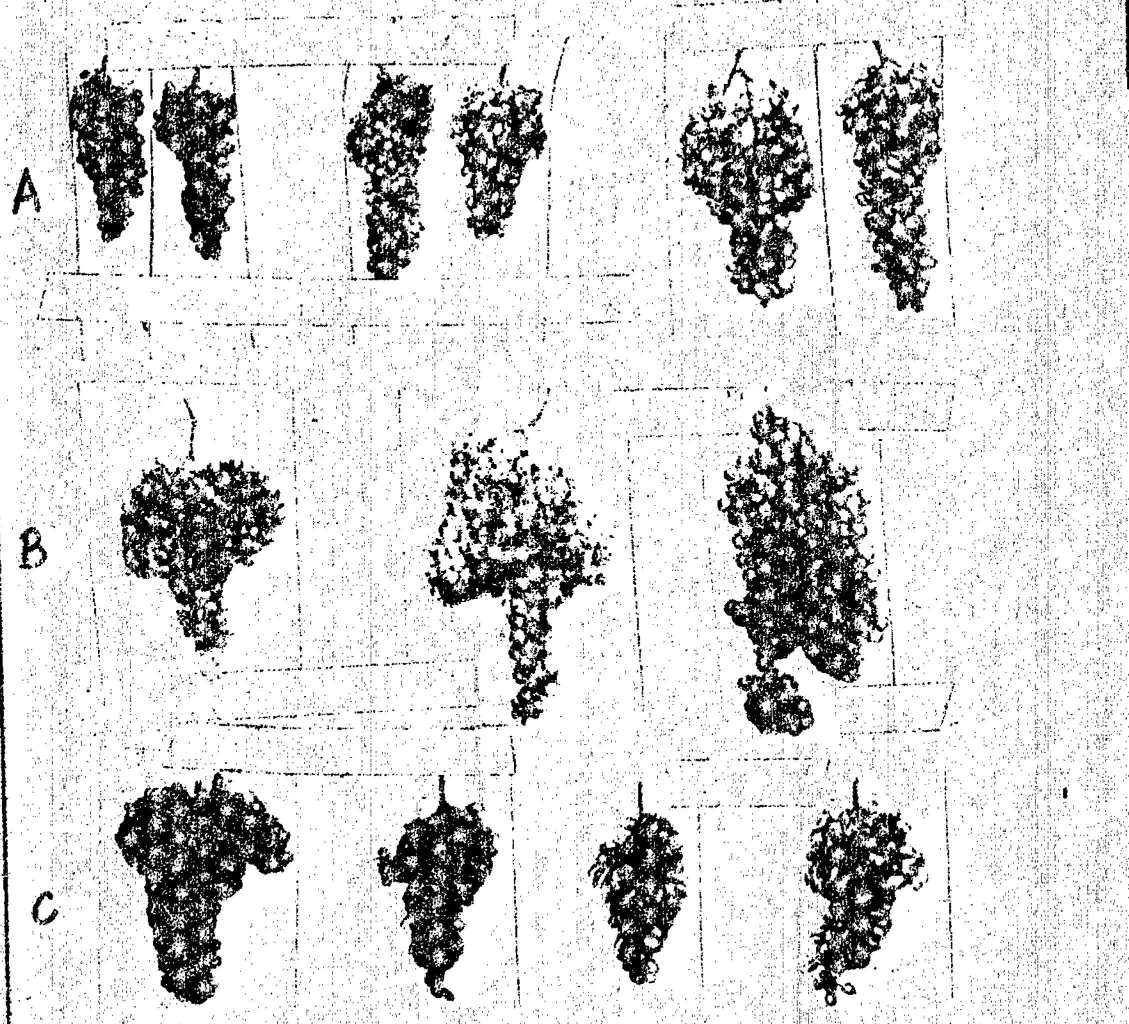

Figure 1. The effect of gibberellic acid on the size of grape berries of monoecious seedless variety. A-Oval Kishmish variety (left to right): two bunches, control; two bunches treated with gibberellic acid in a concentration of 5 mg per liter; two bunches treated with the same acid in a concentration of 100 mg per liter; B-Round Kishmish variety (left to right, one bunch for each treatment): control bunch; a bunch treated with gibberellic acid in a concentration of 1 mg per liter; a bunch treated with gibberellic acid in a concentration of 25 mg per liter; C-Askeri variety(left to right,one bunch for each treatment):control bunch;bunches treated with gibberellic acid in concentrations of 5 mg per liter, 25 mg per liter, and 100 mg per liter.

Table 1

The effect of gibberellic acid on the size of berries of monoecious seedless grape varieties

Variety	Concentration of gibberellic acid, mg/l	Average weight of berry, g	Size of berry, cm length	width	Length to width ratio	sugar content percent
Askeri	Control	1.45	1.54	1.16	1.32	22.7
	5	1.35	1.55	1.13	1.37	20.1
	25	1.20	1.50	1.02	1.47	21.0
	100	1.42	1.71	1.02	1.66	23.0
Kishmish oval	Control	1.0	1.33	1.04	1.28	21.0
	5	1.37	1.44	1.12	1.29	26.0
	100	1.98	1.78	1.26	1.41	22.5
Kishmish round	Control	0.86	-	-	-	18.2
	1	1.15	-	-	-	22.9
	5	1.0	1.12	1.13	0.99	18.8
	25	1.10	-	-	-	18.9
	100	1.67	1.34	1.30	1.03	22.6
Kishmish yellow	Control	0.70	-	-	-	21.9
	500	1.18	-	-	-	24.4

The average weights of the oval kishmish berries were the following: control - 1 g; berry from bunch treated with gibberellic acid (5 mg per liter) - 1.37 g; berry from bunch treated with gibberellic acid (100 mg per liter) - 1.98 g, i.e., a weight almost double that of the control. In the yellow kishmish variety the weight of the control berry was 0.70 g, and the weight of a berry treated with 500 mg gibberellic acid per liter was 1.18 g. In the round kishmish variety the average weight of the control berry was 0.86 g and that of the same variety treated with 100 mg gibberellic acid per liter was 1.67 g.

No increase was observed in the average weight of the Askeri berry. However, the length-to-width ratio varied from 1.32 in the control berry to 1.66 after treatment with gibberellin in a concentration of 100 mg per liter. The same tendency was observed in the oval kishmish variety.

Of the monoecious varieties, which normally produce seeds in their berries, the Alburla and Royal Vineyard varieties were investigated.

In the Alburla variety the treatment with gibberellic acid caused a decrease in the size of the berries but left their shape almost unchanged. All the berries of this variety, in both the control and experimental bunches, were with seeds. The treatment of the shrubs of the Royal Vineyard variety with gibberellic acid in concentrations of 5 and 25 mg per liter did not increase the average weight of the berry, but the number of seedless berries increased substantially. Furthermore, the latter berries were completely normal in appearance and size, while the seedless berries of the control bunches were very small and parthenocarpic.

In the test with the Nimrang and Pukhlyakovskiy varieties, which possess a functionally female type of flower, a part of the treated inflorescences of these varieties was immediately covered with parchment isolators in order to prevent pollination by a foreign pollen. The other inflorescences were left exposed and subjected to pollination.

The results obtained from the treatment of inflorescences of the Nimrang and Pukhlyakovskiy varieties with solutions of gibberellic acid are given in Table 2.

Table 2

The effect of gibberellic acid on the size of berries of grapes with a functionally female type of flower (isolated for the entire duration of flowering)

Variety	Concentration of gibberellic acid, mg/l	Average weight of berry, g	Size of berry, cm		Length to width ratio	Sugar content percent
			length	width		
Pukhlyakovskiy	Control	The berries did not set, the bunch dried off				
	5	1.37	1.47	1.08	1.36	23.3
	25	1.56	1.84	1.24	1.48	23.8
	100	1.84	2.10	1.31	1.60	24.3
	500	2.15	2.11	1.25	1.69	23.1
Nimrang	Control	1.08	1.17	1.18	0.99	24.8
	5	1.41	1.36	1.29	1.05	21.3
	25	1.40	1.47	1.29	1.14	19.8
	100	2.17	1.45	1.21	1.20	17.6
	500	2.61	1.84	1.41	1.30	17.6

The treatment with solutions of gibberellic acid led to some decrease in the size of the berries produced under conditions of open pollination, though in the Pukhlyakovskiy variety the treatment with a 100 mg per liter solution resulted in some increase in the average weight of the berries.

However, in the absence of pollination in the varieties with a functionally female type of flower, when the flowering took place in parchment isolators and only parthenocarpic berries could develop, the favorable effect of gibberellin was strongly in evidence. In the control bunches of the Nimrang variety the average weight of a berry was 1.08 g, and those treated with a 500 mg per liter solution weighed 2.61 g. Naturally, the berries were seedless. In the Pukhlyakovskiy variety, the isolation of inflorescences for the duration of flowering caused complete withering of the bunch. The treatment of inflorescences with gibberellic acid before isolation produced an abundant formation of seedless berries, and the size of the berries increased with the concentration of gibberellic acid, to a size which is almost normal for this variety. In this case, the bunch became extremely thick.

From the observations it was clear that also in varieties producing normal seeds a treatment with gibberellic acid causes considerable changes in the formation of the bunch as well as in the shape and size of the berry; it sometimes also causes the seeds to atrophy, so that completely seedless berries result.

From the preliminary data obtained it is rather difficult to draw any definite conclusion as to the effect of the gibberellic acid treatment of grape inflorescences and bunches on the accumulation of sugar in the grapes. Apparently, the biological peculiarities of each variety is of great importance here. For example, the Kishmish varieties show a clear tendency toward an increase in the sugar content of the berries following treatment with gibberellic acid. In the bunches with seedless berries of the Nimrang variety and in the berries of the Alburla and Royal Vineyard varieties, the accumulation of sugar is considerably retarded by treatment with gibberellin. In the Pukhlyakovskiy and Nimrang varieties subjected to open pollination, the sugar content of the berries in the control group and of those treated with gibberellin solutions is practically the same except in some isolated cases.

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THE EFFECT OF GIBBERELLIN ON THE FRUIT BEARING OF THE CHAUCHI GRAPE PLANT

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(Pages 348-350)

In recent years the problem of the effect of various stimulating substances on the growth of higher plants has acquired very great importance. Among these substances gibberellin has a special place.

It has been established through the investigations by Chaylakhyan [1] that gibberellin has a positive effect on the growth, formation, and generative development of numerous types of plants, enhancing the flowering of long-day types under short day conditions and that of biennial types in the first year of seeding.

On the basis of tests concerning the effect of gibberellin on the growth and development of winter wheat (Gedoninska Golitse variety), spring wheat (Niva variety), and millet (Ganatska Mana variety), Krekule and Martinovska [2] have arrived at the conclusion that the effect of gibberellin on the development of plants cannot be generalized. For instance, gibberellin was not found to affect the development of short-day millet, nor did gibberellic acid affect the growth and development of unvernalized winter wheat. Grebinsky [3] points out that gibberellin employed in small doses increases twofold and more the growth of citrus, maple, kidney bean, tobacco, tomatoe, fodder grass, and other seedlings. He notes that the increase takes place in the growth of the vegetative bulk, while the yield of grain, tuber, or root may even be reduced.

If the data cited here indicates in most cases a positive effect of gibberellin on the growth and

formation of above-ground vegetative organs of many types of plants, the question of whether gibberellin affects fruit bearing still remains vague and experimentally unsolved. Therefore, in 1959, we set ourselves the task of trying to investigate the effect of gibberellin on the fruit bearing of the grape plant.

The gibberellin preparation for the test was received from M. Kh. Chaylakhyan, the whom the author expresses his thanks.

We conducted the test in 1959 at the vineyard of the Uzhgorod Vine-Growing State Farm. The Chauchi variety of grape was taken as the experimental object. This is a high-yield, table variety. In the vineyards of Zakarpat'ye this variety is found mainly mixed with other varieties, and only in individual cases in small, true-bred quantities. Unlike a number of other varieties, the Chauchi possesses a functionally female type of flower. These flowers differ from those of the monoecious varieties in that with their normally developing pistil, they have much shorter stamens and filaments that are bent off (after the corona is shed); they also have a sterile pollen. Consequently, the normal fructification of the Chauchi variety is possible only through intervariety cross pollination.

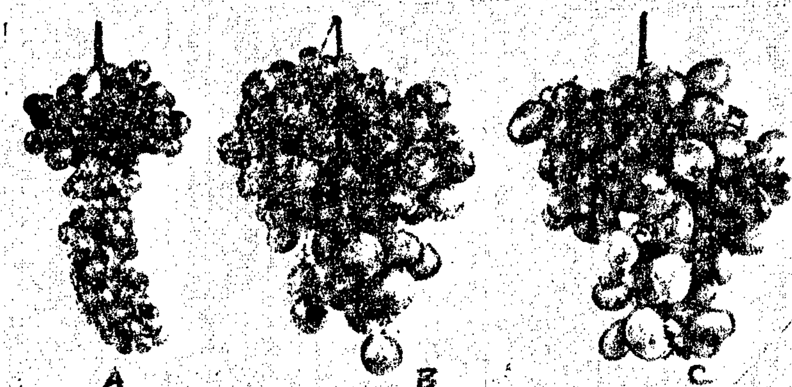
In our investigation of the effect of gibberellin on the fruit bearing of the Chauchi variety, the test was set up as follows: before the beginning of flowering we selected from 20 shrubs 60 inflorescences as nearly identical as possible. All these inflorescences were covered with small, numbered parchment bags.

At the beginning of flowering the experimental inflorescences were divided into three groups, 20 inflorescences in each. To the expanding flower buds of the 20 inflorescences in the first group were applied three times (every other day) the pollen of the Shasla variety. The 20 inflorescences of the second variant were sprayed during the flowering period with an 0.002 percent gibberellin solution.

Since the flowers on one and the same inflorescence open at different times, roughly within a period of three days, it was possible with the threefold spraying for the stimulant to reach the stigmas of almost all flowers on the inflorescence. The spraying was conducted at night, and all precautions were taken against the drift of pollens from the air onto the flowers. Finally, the flowers of the 20 inflorescences in the third group were neither pollinated nor sprayed (control group).

Already within 15 days after the flowering it was easy to notice a difference in the development of the fruits on the experimental bunches. In the group in which the inflorescences had been sprayed with gibberellin solution, the berries had an oblong shape. Their pedicles were thicker and longer than those in the group pollinated by the Shasla pollen.

The results of our tests were recorded during the period of grape harvesting, and are exhibited in the table and the figure below. In analyzing the data shown in the table and figure, it is evident that gibberellin sprayed in a concentration of 0.002 percent has a substantial effect upon the fructification of the grape plants. All bunches of this group had normally developed fruits. The average weight of a bunch was only slightly less than the weight of that given the Shasla pollen, and it exceeded considerably the weight of the control bunch.



The effect of gibberellin on the fructification of grapes
A - control, neither pollinated nor sprayed (the berries look like peas); B - pollinated by Shasla variety pollen (normally developed berries); C - flowers sprayed with a solution of gibberellin (normally developed berries).

Table 1
Development indices of berries in individual test groups

Test Groups	Average weight of bunch, g	Weight of 100 berries, g	Volume of 100 berries, cm^3	Length of berry, mm	Width of berry, mm	Weight of seeds of 100 berries, g	Sugar per-cent	Titer acidity
Pollination with Shaslа pollen	273.0	377	370	20.2	18	3.7	13.5	7.2
Spraying with gibberellin	268.5	378	364.5	22.8	16.8	No seeds	17.0	5.8
Control	80.7	61.8	51	5.2	5.1	No seeds	12.0	6.3

The average weights of one berry of the first two varieties were the same. In the group with gibberellin, the berries had a somewhat oblong shape; they had no seeds and were considerably sweeter in taste. The increased percentage of sugar in this group is apparently explained by the much earlier ripening of the berries. This can also be deduced from the fact that here the berries were much easier to detach from the pedicles and had a much more pronounced golden-yellow shade, which is typical of completely ripe berries of the Chauchi variety.

The results obtained by us offer a solid basis for the assertion that gibberellin not only affects the growth of vegetative organs of many other plants, as has been indicated in literature, but also it promotes the development of the flower button of the Chauchi grape, which leads to the formation of normally developed seedless fruits. Also, it shortens the ripening period of the berries.

It would be premature to extend the results obtained on the positive effect of gibberellin on the Chauchi variety fruits to all other varieties of grape. After all, we were dealing with an object in which no fertilization took place and with no such source of growth substances for the button as is found in a fertilized seed bud. As for the nature of gibberellin's

action upon the fruit bearing of varieties with a functionally monoclinous type of flower, this question, in our opinion, still requires direct experimental clarification.

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THE EFFECT OF GIBBERELLIC ACID ON THE FRUCTIFICATION OF VARIETIES OF GRAPE PLANTS POSSESSING A FUNCTIONALLY FEMALE TYPE OF FLOWER

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(Pages 350-354)

The fructification process in most varieties of grape plants is associated with the fertilization of the seed buds, and any disturbance of the reproductive process -- the absence of a fertile pollen, rainy weather, low temperatures (below +15°) -- during the flowering period will lead to a sharp drop in yield. This is particularly emphasized in varieties with a functionally female type of flower (Chauchi, Nimrang, Pukhlyakovskiy, and others) which is incapable of self-fertilization owing to the sterility of the pollen.

A new phase in the development of methods for controlling the fructification process commenced when it appeared that growth stimulants could be used in this field. Among the growth-promoting substances employed in horticulture, gibberellin was of special interest. The comprehensive study of gibberellin both in our country and abroad has resulted in an accumulation of interesting data on its effect on plants. According to the data by Chaylakhyan [1, 2, 3], Lang [4, 5], and Phinney [6], gibberellins advance the beginning of flowering both of long-day types under short-day conditions, replacing the long-day photo-induction period, and of winter-type seedlings and biennials in the first year of life, replacing vernalization; under the influence of gibberellin, dwarf plants reach the height of normal plants. After treating Korinka Black grapes with

gibberellic acid in concentrations ranging from 5 to 500 mg per liter, Weaver [7] was able to observe the setting of berries of much larger than usual size. Through the works of Wittwer and others [8] and Moslov and Mosolova [9] it has been established that by spraying the inflorescences of tomatoes, peppers, and cucumbers with gibberellin in ratios of 10 to 100 per 100,000, it was possible to obtain fruits without fertilization (pathenocarpic).

Despite the information available on the effect of gibberellin on a series of crop plants, we still did not have sufficient data at our disposal on its application in viticulture, particularly for obtaining normally developed seedless berries of grape varieties with a functionally female type of flower. We have therefore set up tests in order to investigate the effect of gibberellic acid on the fructification process of the Chauchi and Nimrang varieties which have functionally female types of flower.

The experimental part was carried out at the Novo-Dzhankoyskiy vine-growing State farm of the Crimean oblast and at Salgirka, the training and experimental farm of the Crimea Agricultural Institute im. M. I. Kalinin.

The gibberellic acid used in our tests was obtained from the Institute of Plant Physiology im. K. A. Timiryazev, Academy of Sciences USSR; aqueous solutions as well as the powdered acid were used in the following concentrations: solutions - 10, 50, 100, and 150 mg per liter; powdered form - 1, 5, 10, and 15 mg per g.

For fillers we tried Kil clay, grapevine ashes, and beet sugar. All the above-mentioned concentrations were applied to varieties with inflorescences isolated (with parchment isolators) to prevent the entry of foreign pollens, as well as to unisolated varieties (intervariety pollination plus the treatment with the growth stimulant). In order to determine the effect of the number of treatments, single and double pollination as well as a single and double spraying of the experimental inflorescences were carried out. The first treatment of the inflorescences with gibberellic acid was made during the period of mass flowering, and the second was made ten days after the first. For the Nimrang variety there were additional groups in which the first treatment of inflorescences was conducted five days after the end of flowering and the second

2

treatment ten days after the first.

The control groups were: (1) open cross pollination of the Chauchi inflorescence with Shasla White pollen, and open cross pollination of Nimrang with a pollen of a mixed variety; (2) inflorescences isolated from cross pollination. In each of the variants there were 10 to 25 experimental inflorescences. The solutions of the stimulant were applied to the inflorescences with an atomizer, and the powdered substance by means of a manually operated duster. With 100 g of solution we treated 50 inflorescences of Chauchi variety and 30 inflorescences of the Nimrang variety (these were larger); with one gram of powder we dusted 25 inflorescences of the Chauchi variety and 15 inflorescences of the Nimrang variety. The growth stimulant was applied to the inflorescences during the morning hours (from 8 to 10). In the course of the work the following were determined and recorded: the number of flowers in an inflorescence, the number of berries in a bunch, the

Table 1

The effect of fillers for gibberellic acid on the fructification process of the Chauchi and Nimrang varieties

Fillers and solvents	Concentration of gibberellic acid	Percentage of setting of berries	Average weight of bunch, g
	Chauchi variety		
Distilled water	100 mg/ltr	44.0	390
Beet sugar	10 mg/ltr	48.9	406
Ashes of grapevine	10 mg/ltr	49.6	416
Kil clay	10 mg/ltr	50.2	381
Control (open cross pollination)		20.0	170
	Nimrang variety		
Distilled water	100 mg/ltr	33.9	655
Beet sugar	10 mg/ltr	35.0	698
Ashes of grapevine	10 mg/ltr	35.8	727
Kil clay	10 mg/ltr	30.5	657
Control (open cross pollination)		17.8	371

Note. The table gives the data of only one of the concentrations tested, since the same regularity of the effect of the fillers appears at other concentrations.

average weight of 100 berries, the average weight of a bunch, the average weight of 100 seeds and the number of seeds in 100 berries, and the percentage of sugar, acid, and dry substance in the berries. All these determinations were carried out in accordance with generally accepted methods. Below are the results by individual test variants.

The effect of fillers for gibberellic acid on the setting rate of berries and the average rate for a bunch

The results obtained on the effect of gibberellic acid fillers in a double treatment of the isolated inflorescences are given in Table 1.

As seen from Table 1, the maximum weight of a bunch of the Chauchi variety, 416 g, and of the Nimrang variety, 727 g, is obtained with the use of grapevine ashes as filler. The absence of sharp variations in the average weight of the bunches, depending on the fillers used, points to the fact that in addition to grapevine ashes, Kil clay and beet sugar may also be successfully employed, and that water may be used for the preparation of solutions. In this connection we quote in Tables 2 and 3 the results of only those groups for which grapevine ashes were used as the filler for gibberellic acid, despite the fact that we had the data on all fillers tested.

The effect of the concentration of gibberellic acid on the fructification process of the Chauchi and Nimrang varieties

As shown by the test results, the concentration of gibberellic acid has a great effect upon the process of fructification. The effectiveness of the growth stimulant at various concentration is given in Table 2.

Analyzing the data of Table 2, we arrive at the conclusion that with an increase in the concentration from one to 15 mg/g, the average weights both of the bunch and of 100 berries increase sharply. When isolated inflorescences were treated twice with gibberellic acid in a concentration of one mg/g, the weight of the bunch was 244 g, and when the concentration was 15 mg/g the bunch weighed 423 g; the average weight of the berries increased accordingly from 201 g to 336 g; at this point the average weight of a control bunch

Table 2

The effect of concentration of gibberellic acid on the fructification of Chauchi variety grapes

Test group	Concentration of gibberellic acid	Single treatment			Double treatment		
		Average weight of 100 berries, g	Average weight of a bunch, g	Setting of berries, percent	Average weight of 100 berries, g	Average weight of a bunch, g	Setting of berries, percent
Open cross	1	148	155	42.2	261	331	45.5
pollination + treatment with	5	176	215	45.2	273	336	48.5
gibberellic acid	10	191	258	49.8	283	418	59.7
	15	139	251	49.8	304	428	55.9
Inflorescences isolated + treatment with gibberellic acid	1	158	182	41.0	201	244	43.0
	5	172	201	43.9	279	344	41.0
	10	180	225	44.5	320	416	49.6
	15	186	236	44.6	336	423	43.9
Control (cross pollination)	-	297	174	22.1	300	170	20.0

equalled 170 g, and the average weight of 100 berries was 300 g. A structural analysis of the bunch showed that concentrations higher than 10 mg/g considerably enhanced the effect of the stimulant with respect to changes in the stalks. With increased concentrations, the stalks of the grape bunches become longer, they lignify quickly, and the berry stalks lose their elasticity, which sharply reduces the transportability of table-variety grapes. Therefore, concentrations ranging from 5 to 10 mg/g must be regarded as optimal for powder-like fillers, and those ranging from 50 to 100 mg/g as optimal for solution fillers.

Increases in the weight of the bunch and in the average weight of 100 berries were obtained through a double treatment of inflorescences with gibberellic acid. No visible effect of the growth stimulant upon the grape leaves was observed.

As indicated above, a number of inflorescences of the Nimrang variety were treated with gibberellic acid (concentration 10 mg/g) once five days after flowering and again 10 days after this. In these groups there were obtained bunches with parthenocarpic berries which differed little in shape and size from those of the control group.

The effect of gibberellic acid on the percentage of setting, the morphological changes, and the chemical composition of the berries

It has been established that with a double treatment of inflorescences with gibberellic acid in a concentration of 10 mg/g, the percentage of Chauchi variety berries set increased from 20 (control) to 59.7 percent in the unisolated inflorescences and to 49.6 percent in those isolated. In the Nimrang variety treated similarly, it increased from 17.8 (control) to 38.4 percent in the unisolated and to 33.1 percent in the isolated inflorescences. It should be noted that on individual inflorescences the percentage of berries set increased to 85-90 percent. This gives rise to the assumption that it is possible to achieve with the aid of growth stimulants an almost 100 percent setting of the berries on an inflorescence. After isolated inflorescences were treated with gibberellic acid, all berries in the bunch were parthenocarpic; the treatment of unisolated inflorescences resulted in the development of 15 to 20 percent berries with seeds in the bunch, due to the cross pollination before the beginning of treatment of inflorescences with growth stimulants.

Table 3

The effect of gibberellic acid on both the ripening dates and chemical composition of berries of the Chauchi and Nimrang varieties

Pollination variants	13 August			28 August			13 September			28 September		
	Sugar	Dry substance	Acidity	Sugar	Dry substance	Acidity	Sugar	Dry substance		Sugar	Dry substance	Acidity
Chauchi variety												
Inflorescences isolated + treatment with gibberellic acid	11.9	15.6	3.8	18.9	18.1	3.1	21.4	18.3	2.7	-	-	-
Open pollination + treatment with gibberellic acid	8.6	14.3	5.6	17.3	17.1	4.2	13.7	17.8	3.5	-	-	-
Control (open pollination)	5.2	10.8	12.0	9.6	12.7	10.1	14.5	15.5	6.8	-	-	-
Nimrang variety												
Inflorescences isolated + treatment with gibberellic acid	8.1	12.4	12.3	14.8	14.9	6.2	19.8	18.2	3.9	24.1	19.0	3.6
Open pollination + treatment with gibberellic acid	7.0	12.1	13.1	19.3	13.6	8.1	17.1	17.8	5.3	20.4	18.7	5.2
Control (open pollination)	4.2	11.8	22.6	5.3	12.4	20.0	10.6	13.6	187	16.6	16.4	2.6

The parthenocarpic berries obtained in the treatment of inflorescences with gibberellic acid were oblong-oval in shape, in contrast to the control group berries, which were oval.

The gibberellic acid had a great effect on the ripening of the grapes. Bunches of both the Chauchi and Nimrang varieties, whose inflorescences were treated with gibberellic acid, ripened 15 to 20 days before those of the control group.

Table 3 shows data on the groups of inflorescences treated twice with gibberellic acid in a concentration of 10 mg/g.

The results obtained show that gibberellic acid enhances the increase in sugar content, the decrease in the acidity of cellular fluid, as well as an increase in the percentage of dry substance in the berries. Thus, for example, in the berries of the Chauchi variety on inflorescences not treated with the growth stimulant (control), the sugar content during the harvesting (13 September) amounted to 14.5 percent, and that in the berries of the inflorescences treated with the growth stimulant was 21.4 percent; corresponding percentages of dry substances were 15.5 (control) and 18.3 percent. The same regularity was observed in the Nimrang variety.

In addition to the tests on the effect of gibberellic acid on the fructification process in varieties with a functionally female type of flower structure, tests were conducted on obtaining normally developed bunches on greatly falling clones of the Riesling variety. The data obtained confirm the possibility of obtaining a normal yield from these clones by a double treatment of the inflorescences with gibberellic acid in a concentration of 10 mg/g.

In conclusion, I express my gratitude to Prof. P. T. Bolgarev for directing the work and to Prof. M. Kh. Chaylakhyan for providing the gibberellin for the tests.

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THE ACCELERATION OF FLOWERING OF SHORT-DAY PLANTS BY TREATMENT WITH GIBBERELLIN

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(Pages 354-357)

Cocklebur, soyabean, kalenchoe perilla, and Mamont tobacco will not begin to flower under long-day conditions when treated with gibberellin /_1-5_/. What is more, the spraying with gibberellin of kalenchoe plants raised under short-day conditions cancels out the accelerating effect of short-day treatments /_1a_/. On this basis, the general statement was made that it is impossible to promote the development of short-day plants by treatments of gibberellin. It is thought that short-day plants contain enough natural gibberellins so that their flowering is not promoted by treatment, unlike the long-day plants /_5_/. At the same time it is known that gibberellin treatments strongly affect the nature of the growth and shaping processes in both long-day and short-day plants. In more recent investigations conducted on cocklebur, it was shown to be possible to accelerate the course of photoperiodic induction in this short-day plant with the aid of gibberellin /_6,7_/.

It seemed essential to determine whether the result obtained on cocklebur was typical of short-day plants. With that end in view, we organized tests on perilla (Perilla ocymoides), Italian hemp, and sunflower (giant).

Tests on perilla. Starting from the moment of germination, the plants were grown for 15 days under

constant illumination, and then divided into two equal groups. The plants of one group were sprayed once with a 0.01 percent solution of gibberellin after which (31 July) they were put on various daily illumination schedules. Simultaneously, we give the same daily illuminations to control plants not treated with gibberellin. The setup and results obtained are shown in Table 1.

Table 1

The number of days from the moment of placing the perilla under short-day conditions to the moment of budding: plants raised under various photoperiodic conditions

Conditions of preliminary treatment of plants	Always a 24-hour day	Short days (hours per 24-hr day)					Always a 12-hour day
		6	9	12	15	18	
Control	None	None	None	33	32	26	20
Gibberellin, 0.01 percent	None	None	36	28	24	22	20

It is quite obvious that the preliminary treatment of plants with gibberellin did not result in their budding under conditions of a 24-hour day; nor was budding promoted while the plants were kept under conditions of a 12-hour day. At the same time the gibberellin treatment proved to be very effective under the short-term influence of short days within 9-18 days. The control plants, kept for nine 24-hour days under short-day conditions and later transferred to a full 24-hour day, did not bud. Under the same conditions of day duration, plants treated preliminarily with gibberellin produced buds on the 36th day. From Table 1 it can be seen that gibberellin accelerated the course of the photoinductive processes in the short-day plant perilla.

Test on Italian hemp. Hemp, being a short-day plant, is not influenced by the length of day for the first 15 days after germination [8]. The photoperiodic reaction of hemp has another specific feature. If the plants are illuminated for a small number of short days, insufficient to produce flowering under long-day conditions, the reaction to the length of day will nevertheless reveal itself. On these plants it is possible to

observe the appearance of simple leaves instead of compound ones (Fig. 1). True, as the plant keeps growing under 24-hour illumination, compound leaves will form again after the simple leaves. In spite of this, the presence of simple leaves on hemp plants indicates that the plants were subjected to short-day action which was felt by the plants.

Figure 1. Leaves of Italian hemp plants illuminated for eight short days from the moment of germination. Left: control leaves; right: leaves treated with gibberellin.

The purpose of the test was to find out whether gibberellin treatment would accelerate the perception of short-day conditions by the sprouts of hemp. For this purpose, beginning with the moment of germination the hemp plants were exposed to 2, 4, 6, 8,...,22-hour short days, after which they were placed on a 24-hour day. The test were in two series: a control (without gibberellin treatment) and an experimental series, in which the plants were sprayed with gibberellin solution daily as long as they were under short-day conditions (i.e., 2, 4, 6,...,22).

In each test group there were 15 plants. One month after termination of the short-day treatment of the plants, we counted in each group the number of plants having only compound leaves, i.e. the plants that showed no reaction to photoperiodic action. The count results are given in Table 2.

Table 2
Number of Italian hemp plants that showed no reaction to short-day treatment (no change in leaf structure)

Test series	The number of short days received by the plants from the moment of germination										
	4	6	8	10	12	14	16	18	20	22	24
Control -- without treatment	15	15	15	14	13	11	10	6	3	1	0
Daily treatment with gibberellin during short-day illumination	15	13	3	1	0	-	-	-	-	-	-

It turned out that the control plant reacted fully to short-day conditions only when they lasted for 20-24 days. The same effect was obtained for plants treated with gibberellin after much briefer exposure -- eight to 12 short days.

It is quite obvious that the combined action of a short day with a treatment of gibberellin increases the photoperiodic sensitivity of hemp, which is a short-day plant.

Thus, perilla and Italian hemp, being short-day plants, perceived the short day more effectively when they were treated with gibberellin either preliminarily (perilla) or daily during short-day exposures (hemp).

It may be assumed that in both cases gibberellin acted primarily to promote the growth of the stem and the activity of the axillary buds. As a result of treatment with gibberellin, perilla as well as hemp grew to approximately one and a half to twice the normal height. The high physiological activity of the buds in the axils of the leaves can be judged from the fact that all the treated plants, upon being transferred to long-day conditions, produced vigorous stem shoots. In the control plants the identical buds of the same formation were of the resting /_ latent_/ type and produced no branching.

The results of our tests agree completely with the data obtained on cocklebur /_ 6, 7_/. The promotion of the growth activity of the buds under the effect of gibberellin (in cocklebur as well as in our media, (perilla and hemp) ensures a more rapid perception of photoperiodic conditions. Contrary to the opinion of

a number of researchers, the treatment of short-day plants with gibberellin can markedly accelerate their development under conditions of short-term exposure to a short day.

Figure 2. Sunflower plants (giant) raised under constant illumination. Left: control plants; right: plants treated (for 30 days) with gibberellin. The latter formed anthodia.

Test with sunflowers (giant). This sunflower variety is a facultative short-day plant. It begins to flower earlier under short-day conditions and much later under continuous illumination. The plants were raised on both 24- and 13-hour days. One-half of the plants under both photoperiods were treated daily for 30 days with a solution of gibberellin (0.01 percent), while the other half were not treated and served as the control.

The treatment of the plants with gibberellin very strongly affected the growth and morphology of the sunflowers (Table 3). Under both 24-hour and 13-hour day conditions the height of the plants increased (by 20 to 30 percent). The stem had eight to 10 more leaves. The morphology of the leaf changed strongly. Under the effect of gibberellin, the width of the leaf blade decreased to half of the size. The leaf acquired a drawn-out, elliptic shape. There was a marked change in the shape of the leaf blade at the egress point of the leaf scion. In place of the well-pronounced heart-shaped base of the leaf in the control specimens, the experimental leaf base acquired an orbicular wedge-shaped structure. Thus, the leaf shape characteristic

of the sunflower was lost under the effect of gibberellin. The weight of the leaf blade in the experimental plants decreased to less than one third the normal weight.

Table 3

The response of sunflowers (giant) to treatment with gibberellin when raised under different conditions of day duration

1 Длина дня	2 Высота растений, см		3 Число дней до цветения 50% растения		4 Листья						8 Сырой вес в г					
					5 число на одно растение		6 ширина		7 длина		9 одного листа		10 стеблей		11 Корзинок	
	к*	г**	к.	г.	к.	г.	к.	г.	к.	г.	к.	г.	к.	г.	к.	г.
24 ч.	188	236	12 Нет цветения	80	36	46	11	5	15	13	4,0	1,5	194	136	5	46
13 ч.	134	189	74	74	30	42	10	5	17	11	4,9	1,3	79	95	83	61

* k — control group, the plants were not treated with gibberellin.

** f— plants treated with gibberellin.

1) — Duration of day; 2) — height of plants, cm; 3) — number of days before flowering, 50 percent of the plants;

4) — leaves; 5) — number of leaves per plant; 6) — width; 7) — length; 8) — raw weight, g; 9) — of one leaf; 10) — of stems; 11) — of anthodia. 12) No flowering.

The treatment with gibberellin strongly affected the development of the plants. Under a 13-hour day and conditions favoring development, the flowering of both experimental and control plants was simultaneous and relatively rapid (flowering on the 74th day).

Under conditions of a 24-hour day, the plants treated with gibberellin began to flower on August 23, the 80th day after germination. The control plants never blossomed before the termination of the test (September 16), although by that time they had flower buds (Fig. 2). Thus, under conditions of constant illumination gibberellin accelerated the flowering of the facultative short-day sunflower by more than 24 days. Judging from the literature, the result obtained on the giant sunflower is the first case in which a short-day plant under the influence of gibberellin experienced accelerated flowering under conditions of constant illumination (not the optimal photoperiod).

The results obtained have made us regard most cautiously the propostion advanced categorically by a number of authors, suggesting that the treatment of short-day plants with gibberellin cannot promote their development.

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